DESCRIPTION

VEHICLE FOR RUNNING ON RAIL

TECHNICAL FIELD

The present invention relates to a vehicle for running on rail (tracked vehicle), and particularly the vehicle having the capability of providing smooth running, while moderately maintaining a grip force on the rail.

BACKGROUND ART

In a vehicle for running on rail, there is a case that a reduction in grip force that is friction resistance between a drive wheel and the rail poses a problem for the vehicle's running. For example, slippage easily occurs on the rail in the rain. In particular, when the vehicle runs on an inclined rail in the rain, it becomes a serious problem.

To solve this problem, it is needed to increase the grip force by pressing the drive wheel against the rail. However, an excessive increase in the grip force leads to an increase in energy needed for the vehicle's running. As a result, it becomes difficult to provide efficient running of the vehicle on the rail.

In addition, to obtain a moderate grip force, it has been proposed to monitor a weight of the vehicle by a weight sensor, and control a spring constant of a spring member for pressing the wheel against the rail according to the monitored weight. However, there are problems that the control becomes complex, and a total cost of the vehicle track system increases.

In addition, Japanese Patent Early Publication [kokai] No. 3-70670 discloses a track device system with a running unit for running on a rail. As shown in FIG. 9, the running unit **100** used in this device has a drive wheel **110** rotatable on an upper surface of the rail **1**, and a pair of auxiliary wheels **120** rotatable on a lower surface of the rail, and has the capability of running, while holding the rail between the drive wheel and the auxiliary wheels. A curve region of the rail is designed to be different in rail width from a straight region of the rail such that an overlapping amount between the auxiliary wheel

and the lower surface of the rail is not larger than a constant value. Thereby, it is possible to prevent that an excessive reaction force loads on the drive wheel **110** and the auxiliary wheels **120**, and provide smooth running on the rail **1**.

However, in such a track device, it is needed to manufacture the rails having different widths every curve region. Therefore, when a total length of the rail is long, or many curve regions are designed in the track device, an increase in cost of the track device is unavoidable.

Thus, from the viewpoints of considering the cost performance of the entire track device, and providing smooth running of the vehicle, while moderately maintaining the grip forces of the wheels on the rail, there is still plenty of room for improvement in the conventional vehicle for running on rail and the system using an expensive control unit or the design change of the rails.

SUMMARY OF THE INVENTION

In view of the above problems, a primary concern of the present invention is to provide a vehicle for running on a rail having the capability of moderately generating a grip force of a wheel (drive wheel) on the rail according to a total weight of the vehicle (including loads), and realizing efficient and smooth running, despite its relatively simple structure.

That is, this vehicle has a base; a pair of first and second wheels held by the base to be rotatable on an upper surface of the rail and spaced from each other in an extending direction of the rail; a third wheel held by the base to be rotatable on a lower surface of the rail; and a motor for driving at least one of the first and second wheels. The first wheel is positioned between the second wheel and the third wheel in the extending direction of the rail, and the second wheel is held by the base through a cushioning member.

According to the present invention, when the cushioning member such as a coil spring is elastically deformed downward by receiving a weight of the vehicle and loads carried on the vehicle, the vehicle takes an inclined posture such that the second wheel side having the cushioning member of the base comes close to the rail. At this time, the third wheel positioned at a side

opposed to the second wheel through the first wheel is pressed against the lower surface of the rail according to the principle of leverage with a fulcrum that is the contact point between the first wheel and the rail. Thereby a force for holding the rail between the first wheel and the third wheel, i.e., the gripping force is obtained. In addition, since an amount of the elastic deformation of the cushioning member, i.e., an inclination degree of the vehicle changes according to the weight of received from the vehicle, the rail gripping mechanism of the present invention can provide a moderate gripping force according to the vehicle's weight. Therefore, when the elastic deformation capability of the cushioning member and the position of the third wheel are appropriately determined, it is possible to provide the moderate gripping force between the wheel and the rail according to the weight of the vehicle (including the loads) without using a special device for monitoring the vehicle's weight and controlling the spring constant of the spring member for pressing the wheel against the rail according to the monitored weight. As a result, it is possible to provide efficient and smooth running of the vehicle.

In a preferred embodiment of the present invention, a distance between the first wheel and a center of gravity of the vehicle in a running state is greater than the distance between the second wheel and the center of gravity, and shorter than the distance between the third wheel and the center of gravity. In this case, since the second wheel is disposed in the vicinity of the center of gravity of the vehicle, the cushioning member can be elastically deformed more effectively at a slope region of the rail to obtain the gripping force.

In addition, it is preferred that the third wheel is comprised of at least two wheels spaced from each other in the extending direction of the rail. In this case, since the plural third wheels contact the lower surface of the rail, it is possible to increase the friction resistance, and further improve the gripping performance on the rail.

Moreover, it is preferred that the vehicle has an auxiliary wheel held by the base to be rotatable on a side surface of the rail under at least one of the first

and second wheels. In this case, since the first and second wheels are guided to prevent derailment, the running safety of the vehicle can be further improved.

Further features of the present invention and effects brought thereby will be clearly understood from the best mode for carrying out the invention described below, referring to the attached drawings.

BRIEF EXPLANATOIN OF THE DRAWINGS

FIG. 1 is a side view of a vehicle for running on rails according to a preferred embodiment of the present invention;

FIG. 2 is a top view showing a seat arrangement in the vehicle;

FIG. 3 is a partially enlarged view showing a wheel arrangement of the vehicle;

FIG. 4 is a view showing first and third wheels of the vehicle on the rails;

FIG. 5 is a view showing second wheels of the vehicle on the rails;

FIGS. 6A and 6B are conceptual diagrams illustrating the principle of generating a gripping force of the vehicle of the present invention on the rail

FIG. 7 is a side view of the vehicle running in a slope region of the rail;

FIG. 8 is a side view of a modification of the vehicle of FIG. 1; and

FIG. 9 is a conceptual diagram of a conventional track device.

BEST MODE FOR CARRYING OUT THE INVENTION

A vehicle for running on rails of the present invention is explained in detail according to preferred embodiments, referring to the attached drawings.

As shown in FIGS. 1 and 2, the vehicle **10** for running on rails of this embodiment has the capability of running on a pair of rails **1** extending in parallel to each other in the forward and backward directions. The vehicle is formed with a base **11**, a body **12** disposed on the base to provide a passenger cabin, a pair of first wheels **20** held by the base to run on upper surfaces **1a** of the rails **1**, a pair of second wheels **30** held by the base to run on the upper surfaces **1a** of the rails **1** and spaced from the first wheels in the extending direction of the rails, a pair of thirds wheels **40** held by the base to run on lower surfaces **1b** of the rails **1**, four auxiliary wheels **50** held by the base to

run on side surfaces **1c** of the rails **1** under each of the first and second wheels, and a motor **2** for driving the first wheels **20**. As shown in FIG. 3, the first wheels **20** are positioned between the second wheels **30** and the third wheels **40** in the extending direction of the rails **1**, and each of the second wheels **30** is held by the base **11** through a cushioning member **32** such as a coil spring.

As shown in FIGS. 4 and 5, the rail **1** has an H(I)-shaped cross section, which is composed of a web **2** of a perpendicular plate, and flanges **3** of horizontal plates integrally connected to upper and lower ends of the web. By connecting the rails by use of joining members (not shown) in the extending direction, a desired rail track can be obtained.

As shown in FIGS. 1 and 2, the body **12** has a space for passengers therein, bumpers **13** at its front and rear ends, and windows **14** formed in the left, right, front and rear sides. In this embodiment, passenger doors **15** are formed above the first wheels, and seats **16** are mainly arranged on the base **11** above the second wheels **30**.

As shown in FIG. 4, the first wheels **20** used in this embodiment are tires made of an elastic material such as rubber tires. A rotating shaft **21** for coupling between the pair of the first wheels is supported by bearing portions **24** mounted on the bottom surface of the base **11**. In addition, a rotational output of the motor **22** mounted on the base is transmitted to the rotating shaft **21** of the first wheels through a power transmission unit including a belt **25** and pulleys **26**. Thus, the first wheels **20** are drive wheels in this embodiment.

As shown in FIG. 5 the second wheels **30** used in this embodiment are tires made of an elastic material such as rubber tires. A shaft **31** for coupling between the pair of the second wheels **30** are held by bearing portions **33** mounted on the bottom surface of the base **11**. In addition, the bearing portions **33** are coupled to the base through the cushioning members **32**. Thereby, when the cushioning members **32** are elastically deformed, the vehicle can take an inclined posture such that the second wheel side of the base **11**

comes close to the rails. In this embodiment, since the rotational output of the motor **22** is not transmitted to the second wheels **30**, the second wheels are non-drive wheels.

As shown in FIGS. 3 and 4, the third wheels **40** used in this embodiment are ties made of an elastic material such as rubber tires. The pair of the third wheels **40** are rotatably held in the vicinity of ends of a pair of frames **41** hanging from both sides of the base **11**. A length of this holding member is determined such that the third wheels **40** contact the lower surfaces **1b** of the rails **1** when the first wheels **20** contact the upper surfaces **1a** of the rails **1**. In the figures, the numeral **42** designates a reinforcing member extending between the bottom ends of the frames **41** and bottom ends of auxiliary frames **51** for holding auxiliary wheels **50** described later.

In this embodiment, the auxiliary wheels **50** are tires made of an elastic material such as rubber tires. Each of the auxiliary wheels **50** is rotatably held in the vicinity of a bottom end of the auxiliary frame **51** to run on the side surface **1c** of the rail **1**, i.e., a surface of the web **2**. The first wheels **20** and the second wheels **30** are guided by the auxiliary wheels to prevent derailment. In this embodiment, a part of the frame **41** for holding the third wheel **40** is used as a part of the auxiliary frame for holding the auxiliary wheel **50** disposed under the first wheel.

Referring to FIGS. 6A and 6B, the mechanism of generating the gripping forces of the above-described vehicle **10** of the present invention on the rails **1** is explained below. As shown in FIG. 6A, when the vehicle **10** is in a horizontal posture on the rails **1**, the rails **1** are caught between the third wheels **40** contacting the lower surfaces of the rails **1** and the first and second wheels (**20**, **30**) contacting the upper surfaces of the rails, so that the gripping forces can be stably obtained between the rails **1** and the first wheels **20** of the drive wheels.

On the other hand, when passengers sit on the seats **16** positioned above the second wheels **30**, as shown in FIG. 6B, the elastic deformation of the

cushioning members **32** is caused by the total weight of the vehicle and the passengers, so that the vehicle takes an inclined posture that the second wheel side of the base **11** comes close to the rails **1**. At this time, according to the principle of leverage or a seesaw motion with fulcrums of the first wheels **20**, the third wheel side of the base **11** receives a force in a direction spaced away from the rails, i.e., the upward direction. However, the upward movement of the third wheel side of the base **11** is prevented because the third wheels supported by the frames **41** are pressed against the lower surfaces of the rails. The forces of pressing the third wheels against the rails work in the direction of reducing the distance between the first wheels and the third wheels. Consequently, the first wheels are also pressed against the rails. Thus, when the vehicle takes the inclined posture due to the elastic deformation of the cushioning members **32**, it is possible to increase the gripping forces of the first wheels, i.e., the drive wheels on the rail.

In the above explanation, the inclined posture of the vehicle is drawn with exaggeration to easily understand the present invention. In this embodiment, since the rubber tires are used as the first to third wheels, the elastic deformation of these tires contributes to the inclined posture of the vehicle. When metal wheels are used in place of the rubber tires, it is preferred that the first wheels and/or the third wheels are held by the base through cushioning members such as coil springs. Thereby, the inclined posture of the vehicle can be obtained in a similar manner to the above.

When the vehicle **10** runs in an inclined section of the rails **1**, the first wheels **20** are the front wheels in the case of ascending the inclined section, and the second wheels **30** are the front wheels in the case of descending the inclined section, as shown in FIG. 7. In this case, since the center of gravity of the vehicle positioned at the side of the second wheels **30**, a larger weight is applied to the cushioning member, so that the vehicle can easily take the inclined posture. Therefore, increased gripping forces can be obtained between the rails **1** and the first wheels **20** of the drive wheels at the inclined section of

the rails, as compared with the case that the vehicle runs in a horizontal section of the rails. From this viewpoint, it is preferred that the distance between the first wheel and the center of gravity of the vehicle in the running state is longer than the distance between the second wheel and the center of gravity, and shorter than the distance between the third wheel and the center of gravity. In brief, the center of gravity of the vehicle in the running state is preferably positioned in the vicinity of the second wheel. In addition, the deformation amounts of the cushioning members **32** increase depending on the weight of the vehicle (including loads). This means that the gripping forces of the first wheels **20** (i.e., the drive wheels) can be increased depending on the vehicle's weight. Thus, according to the present invention, it is possible to provide a moderate gripping force in response to a change of the vehicle's weight by use of the cushioning member having a desired elastic deformation capability.

The vehicle **10** described above has a single third wheel **40** on each of the rails **1**. To further improve the gripping force, the number of the third wheels **40** may be increased. For example, as shown in FIG. 8, a pair of third wheels **40** spaced from each other in the extending direction of the rail may be rotatably held in the vicinity of an end of the frame **41** hanging from the vehicle **10**. That is, the pair of the third wheels **40** are rotatably supported at opposite ends of a supporting member **43**. The supporting member **43** is mounted at its center portion on the frame **41** by use of a pin **45**. As shown by the arrows in FIG. 8, the supporting member **43** is pivotally supported about the pin **45**. Therefore, even when the vehicle takes the inclined posture, all of the third wheels **40** can stably contact the lower surface **1b** of the rail **1**.

In the above components, when the vehicle **10** takes the inclined posture due to the elastic deformation of the cushioning member **32** caused by the vehicle's weight, all of the third wheels **40** can be pressed against the lower surfaces of the rails **1** according to the principle of leverage, as in the case of FIG. 6B. Consequently, the gripping forces of catching the rails between the

first wheels **20** and the third wheels **40** can be obtained. In addition, the gripping forces can be further improved by an increase in contact areas between the third wheels and the rails, as compared with the case of FIG. 6B.

The above embodiment is directed to the vehicle for running on the rails in parallel to each other. However, the vehicle may have the capability of running on a single rail. Needless to say, the vehicle for running on a monorail can provide the same effects as the above embodiment.

The above explanations about the vehicle for running on the rails and the rail system according to the preferred embodiments of the present invention should be interpreted to understand the technical concept of the present invention. Therefore, they do not mean to limit the scope of the invention. In addition, the components of the present invention may be modified, if necessary, on the condition that the modification is in the technical concept of the present invention.

INDUSTRIAL APPLICABILITY

As understood from the above embodiments, the vehicle of the present invention is characterized by having the third wheels rotatable on the lower surfaces of the rails in addition to the first and second wheels rotatable on the uppers surface of the rails, disposing the first wheels between the second wheels and the third wheels in the extending direction of the rails, and holding the second wheels through the cushioning members. Therefore, when the vehicle inclines due to the elastic deformation of the cushioning members, the third wheels are pressed against the lower surfaces of the rails according to the principle of leverage, thereby increasing the gripping forces of the first wheels and the third wheels on the rails. In addition, since the gripping forces change according to the total weight of the vehicle, it is possible to prevent slippage of the drive wheels and provide smooth running of the vehicle by use of a relatively simple mechanism without mounting an expensive device for controlling the grip force in the vehicle. Consequently, it is expected to be utilized as a short distance transport means for passengers or freights as well

as an amusement ride or a traffic means in amusement and theme parks.